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Brief Report: Exploring the Relationship between Sensory Processing and Repetitive  
Behaviours in Williams Syndrome

### Abstract

This study explored the relationship between sensory processing abnormalities and repetitive behaviours in children with Williams Syndrome (WS; n=21). This is a novel investigation bringing together two clinical phenomena for the first time in this neuro-developmental disorder. Parents completed the Sensory Profile (Short Form; Dunn, 1999) and the Repetitive Behaviour Questionnaire (Turner, 1997). A significant correlation was evident between the total scores on each of these measures; suggesting that children with WS who exhibit increased sensory processing abnormalities also display a higher number of repetitive behaviours. Further exploratory analyses of subscales of the measures indicated potentially important relationships that suggest a role for arousal regulation in the relationship between sensory processing abnormalities and repetitive behaviours in WS.

*Keywords:* Williams Syndrome, sensory processing, repetitive behaviour.

*Abbreviations:* WS, Williams syndrome; ASD, Autism Spectrum Disorder; RBQ, Repetitive Behaviours Questionnaire; SSP, Sensory Profile-Short Form.

## Exploring the Relationship between Sensory Processing and Repetitive Behaviours in Williams Syndrome

Williams syndrome (WS) is a neuro-developmental disorder with an estimated prevalence between 1:7,500 (Strømme, Bjørnstad, & Ramstad, 2002) and 1:20,000 (Morris & Mervis, 1999) and is caused by a sporadic deletion of 1.5 MB including 25–28 genes on chromosome 7 (7q11.23; Donnai & Karmiloff-Smith, 2000). Cognitively, the disorder is most often characterised by mild to moderate intellectual difficulty (Searcy et al., 2004) with relative strengths of verbal compared to spatial processing. The disorder is also associated with social, behavioural, and emotional difficulties (for a full review of the literature, see Martens, Wilson, & Reutens, 2008).

In our everyday lives it is essential that we process information from our environment to allow us to respond to that information in an appropriate manner. In both typical and atypical development there is wide variation in the way individuals' process sensory information. Sensory processing can be defined as "the way that sensory information e.g. visual, auditory, vestibular, or proprioceptive stimuli is managed in the cerebral cortex and brainstem for the purpose of enabling adaptive responses to the environment" (Baker, Lane, Angley, & Young, 2008: 867). Critical to the current investigation, sensory processing abnormalities have been identified in up to 90% of children with WS (John & Mervis, 2010). Such problems may relate to impairments of visual, auditory, and tactile perception (e.g. Semel & Rosner, 2003) and / or sensory modulation difficulties (including auditory, vestibular, and proprioceptive hyper- and hypo-sensitivity; John & Mervis, 2010).

Within Autism Spectrum Disorder (ASD), studies have investigated relationships between sensory processing abnormalities and the presence of repetitive behaviours. Repetitive behaviours are defined as “repetitive, non-functional activities or interests that occur regularly and interfere with daily functioning” (Gabriels et al., 2005: 170). It has been suggested that children with ASD who experience sensory processing abnormalities may also experience more repetitive behaviours (e.g. Chen, Rodgers, & McConachie, 2009; Baker et al., 2008). Repetitive behaviours may be functional in regulating arousal levels for children with ASD who experience sensory processing abnormalities (e.g. Gabriels et al., 2008; Liss, Saulnier, Fein, & Kinsbourne, 2006). Furthermore, sensory seeking may be an intrinsic motivator for repetitive behaviours in children with ASD and those with intellectual disability (Joosten, Bundy & Einfeld, 2009). It is important to explore these relationships in children with other relevant neuro-developmental disorders; for example WS.

Repetitive behaviours have been reported in up to 86% of individuals with WS (Davies, et al., 1998). Individuals with WS may engage in obsessive-compulsive behaviours, such as the compulsive need to identify the source of sudden noises or compulsive greeting behaviours (Semel & Rosner, 2003). Although John and Mervis (2010) found evidence of a relationship between sensory processing abnormalities, problem behaviours, and adaptive functioning in children with WS, there are no studies to date that have looked specifically at the relationship between sensory processing and repetitive behaviours in WS. The aim of this preliminary study was therefore to explore sensory processing abnormalities and repetitive behaviours for the first time in children with WS. In line with research from other neuro-developmental disorders, we hypothesise that children with WS who demonstrate more sensory processing abnormalities will exhibit more repetitive behaviours.

## Method

### *Participants*

Twenty-one children with WS aged 6- to 15-years (mean 9.3years; 12 male) were recruited via the Williams Syndrome Foundation. All children had previously been clinically diagnosed and their diagnosis had been confirmed by positive fluorescent *in situ* hybridization testing (FISH). Mean estimated Full Scale IQ (FSIQ) was 52.6 (SD = 11.42), as measured using a Short Form of the WISC-III (Wechsler, 1991), this is within the typical range associated with WS (cf. Mervis, et al., 2000).

### *Measures*

The *Sensory Profile – Short Form (SSP; Dunn, 1999)* is a 38-item parent-report questionnaire asking parents to rate the frequency that their child displays sensory behaviours on a five-point scale (*always, frequently, occasionally, seldom, or never; Dunn, 1999*). There are seven subscales; Tactile Sensitivity, Taste/Smell Sensitivity, Movement Sensitivity, Under-responsive/Seeks Sensation, Auditory Filtering, Low Energy/Weak, and Visual/Auditory Sensitivity. A lower total overall behaviour score indicates greater impairment. The SSP has good internal consistency for the subscales (Cronbach's alpha = .47 – .91), and established content validity and strong inter-rater reliability (Dunn, 2005). Studies have reported that the SSP has discriminate validity of >95% in identifying children with and without sensory modulation difficulties (McIntosh, Miller, & Shyu, 1999). It has been recommended as a good measure for research protocols (Dunn, 1999).

The *Repetitive Behaviour Questionnaire (RBQ)* (Turner, 1995, 1999) is a 33-item parent-report questionnaire measuring the prevalence, frequency, and duration of repetitive behaviours (Turner, 1997). It has excellent inter-rater agreement (mean  $k$  value = .99) and test-retest reliability (mean agreement = .83; Turner, 1999). There are three sub-scales; Repetitive Language, Sameness Behaviour, and Repetitive Movements. Scores are calculated for each subscale and a Total score.

### *Procedure*

Questionnaire packs including the SSP and RBQ were sent to parents of individuals with WS who had agreed to participate in the study. An information sheet was also provided to each parent and child alongside the consent form. The researcher visited each child with WS to complete the WISC-III Short Form in their home. Favourable ethical opinion was granted by Newcastle University Faculty of Medical Sciences Ethics Committee.

### Results

SSP Total Scores and RBQ Total Scores were normally distributed and achieved Cronbach's alpha coefficients above .8, indicating good to excellent reliability. Non-significant correlations were found between FSIQ and the SSP ( $p = .37$ ) and the FSIQ and the RBQ ( $p = .83$ ); therefore the FSIQ was not controlled for in the subsequent analyses.

A two-tailed Pearson correlation revealed a significant negative correlation between the total score of the RBQ and the total score of the SSP ( $r = -.60, p = .01$ ). As repetitive behaviours increased so did sensory processing abnormality.

*[Insert Table 1]*

Further exploration of the subscales of each measure was conducted (see Table 1). The three subscales of the RBQ were correlated with the seven subscales of the SSP. Significant correlations existed between RBQ Repetitive Movement and three subscales of the SSP; Tactile Sensitivity, Taste/Smell Sensitivity, and Under-responsive/Seeks Sensation. RBQ Repetitive Language was significantly correlated with only the Under-responsive/Seeks Sensation subscale. RBQ Sameness of Behaviour was significantly correlated with only the Taste/Smell Sensitivity subscale.

## Discussion

This study revealed a significant relationship between sensory processing abnormalities and repetitive behaviours in children with WS; those who experienced more sensory processing abnormalities demonstrated more repetitive behaviours. The findings mirror reports from other neuro-developmental disorders such as ASD (e.g. Baker, et al., 2008; Chen, et al., 2009; Joosten, et al., 2009). Critically, it is not possible to infer causality or make assumptions about the function of this relationship, but we provide new preliminary insights into the existence of this relationship that can inform future research and have clinical implications.



We use examples from the subscale correlations to propose specific aspects of the relationship between sensory processing and repetitive behaviours in WS. First, RBQ Repetitive Movements were significantly correlated with SSP Tactile Sensitivity. The RBQ Repetitive Movement subscale includes items addressing motoric, physical repetition, such as touching body parts or clothes, repetitive body movements, spinning, etc. The SSP Tactile Sensitivity scale includes rubbing or scratching where being touched, reacting emotionally to touch, not being able to stand too close to others, etc. We propose that engagement in some of the behaviours reported in the RBQ Repetitive Movement subscale occur *as a consequence* of tactile sensitivity. This relationship may be enforced as the child with WS attempts to regulate their arousal, however further research is required to investigate this proposal.

This possible role of arousal may gain some support from the highly significant relationship between RBQ Repetitive Movements and SSP Sensory Under-Responsiveness/Seeks Sensation scale (see Table 1). The latter of these includes behaviours such as seeks movement and fidgets, over excitable during movement activity, touches people and objects, etc. Again, this relationship may link to the requirement to seek sensory stimulation that can regulate arousal. Repetitive behaviours have been proposed to regulate arousal in children with ASD (Gabriels, et al., 2008; Liss, et al., 2006). Research of the nature reported here questions the specificity of that relationship to ASD and considers the possible link between these phenomena across neuro-developmental disorders.

An alternative explanation for this relationship (and indeed for others that we do not have sufficient space to contemplate here), may relate to overlap at the item level between the two scales; reflecting a lack of theoretical clarity between low level repetitive behaviours and

sensory abnormalities. For example, a child rated on the SSP as having high levels of tactile sensitivity is also potentially likely to be rated as frequently touching parts of the body or clothes by their parent. It is unclear whether the relationships reported here result from 'true relationships' between distinct clinical phenomena or are an artefact of poor construct independence and overlapping measurements. However, the relationship between the RBQ Repetitive Movements and RBQ Sameness of Behaviour with SSP Taste/Smell Sensitivity is less likely to be due to consequences of overlapping constructs. It may be that children who are sensitive to tastes and smells experience anxiety around food and use repetitive movements (e.g. self-soothing strategies) to reduce their anxiety (and associated arousal). Similarly, the desire for sameness of behaviour (e.g. wanting to eat the same foods, difficulty reacting to changes in routine etc.) may reduce anxiety for children with WS who are highly sensitive to taste and smell and help regulate arousal when it becomes uncomfortable. This suggestion once again contemplates a role for arousal when considering repetitive behaviours and sensory processing.

There are several clinical implications of the findings of the current study. At present little is known about the experience of these clinical phenomena in WS, or indeed the proposed relationship between them, thus emphasising the novelty and timeliness of the reported study. If more is known about the function of repetitive behaviours in relation to sensory processing abnormalities this knowledge could inform assessment and interventions for children with WS.

This novel exploration makes a significant contribution to the understanding of sensory processing abnormalities and repetitive behaviours in children with WS. However, it is

important to acknowledge some of the limitations. Firstly, a relatively small sample size was achieved due to the low incidence of WS in the general population. As a result of the small sample size this study was underpowered, however, effect sizes were calculated for all analyses and despite a small sample size, moderate to large effects were found. Secondly, as highlighted, very little is known about the phenomenology of sensory processing abnormalities and repetitive behaviours in WS, and therefore the measures used may not be sensitive to assessing these clinical features in this group. Although these measures have been used with children with neuro-developmental disorders, and the SSP has been validated upon samples of children with and without disabilities, both have yet to be standardised on a WS population. Furthermore, as stated, parents' who report excessive repetitive movements are likely to endorse similar items on other scales of the SSP, such as tactile sensitivity, under-responsiveness, etc. Gabriels et al. (2008) recognised that many measures label a behaviour as repetitive on one scale and as sensory on another. In future studies it would be interesting to control for overlapping items to be able to infer more about the pure relationship between sensory processing and repetitive behaviours. Those future studies will also need to explore the mechanisms / functions of repetitive behaviours in relation to sensory processing and whether they serve to regulate arousal as this may suggest links with other clinical features of WS such as anxiety. Further research is needed to support and extend the preliminary findings reported here.

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Table 1. Pearson Correlations between subscale scores on the SSP and RBQ for children with WS (n=21).

<b>Score</b>	<b>RBQ Sameness of Behaviour</b>	<b>RBQ Repetitive Movement</b>	<b>RBQ Repetitive Language</b>
<b>SSP Tactile Sensitivity</b>	-.40 .08	-.48* .03	-.20 .39
<b>SSP Taste/Smell Sensitivity</b>	-.58** .01	-.52* .02	-.29 .22
<b>SSP Movement Sensitivity</b>	-.10 .67	.04 .86	.18 .45
<b>SSP Under-responsive/Seeks Sensation</b>	-.34 .14	-.58** .01	-.54* .01
<b>SSP Auditory Filtering</b>	-.38 .10	-.41 .07	-.31 .18
<b>SSP Low energy/Weak</b>	-.23 .32	-.23 .33	-.01 .96
<b>SSP Visual/Auditory Sensitivity</b>	-.02 .94	-.14 .55	.27 .25

\* Correlation significant at the 0.05 level (2-tailed)

\*\*Correlation significant at the 0.01 level (2-tailed)